REPORT

OF THE

CANADIAN ARCTIC EXPEDITION 1913-18

VOLUME IX

ANNELIDS, PARASITIC WORMS, PROTOZOANS, Etc.

PART A: OLIGOCHAETA

Lumbriculidae . . . . . Frank Smith

Enchytraeidae . . . . . Paul S. Welch

SOUTHERN PARTY, 1913-16

G
670
1913 C2t
v. 9, Pt A
c.3

OTTAWA
J. de LABROQUERIE TACHÉ
PRINTER TO THE KING'S MOST EXCELLENT MAJESTY
1919

Issued September 29, 1919

G
670
1913
C2t
v.009
pt.A
c.3

REPORT

OF THE

CANADIAN ARCTIC EXPEDITION 1913-18

VOLUME IX

ANNELIDS, PARASITIC WORMS, PROTOZOANS, Etc.

PART A: OLIGOCHAETA

Lumbriculidae . . . . . Frank Smith

Enchytraeidae . . . . . Paul S. Welch

SOUTHERN PARTY, 1913-16

OTTAWA

J. de LABROQUERIE TACHÉ

PRINTER TO THE KING'S MOST EXCELLENT MAJESTY

1919

Vol. ix—49455—1

Issued September 29, 1919

EUTC. 1913 J26 v. 9 pt. A c 3

Oligochaeta Collected by the Canadian Arctic Expedition 1913-18.

By Frank Smith and Paul S. Welch.

(With three figures in text.)

An opportunity to examine the collections of Oligochaeta made in the Arctic regions of North America by the Canadian Arctic Expedition has been very welcome, since it has made it possible to materially extend our knowledge of the oligochaete fauna of the Arctic zone as well as that of North America.

The Lumbriculidae and Enchytraeidae are the only families represented, and are the ones which our knowledge of their distribution in the Arctic regions of Eurasia would lead us to expect. A general similarity is found between the oligochaete faunas of the two regions, although they are not identical.

The Lumbriculidae in the collections have been studied and are here dealt with by the senior author, while the part dealing with the Enchytraeidae and including the descriptions of the new species is by the junior author. The collections which are from quite a wide range of localities and a considerable variety of habitats were made by Mr. F. Johansen, the marine biologist, entomologist, and botanist of the expedition.

It is interesting to learn from the field notes of the collector, that some of these worms were found alive in dried-out creek beds and pond bottoms where they had taken refuge in moss or other vegetation. Others were found unharmed by exposure to freezing conditions. In these respects they resemble some of their relatives of more temperate regions.

I.—THE LUMBRICULIDAE[1]

By Frank Smith.

This family is represented by the single genus *Lumbriculus* and there are but two species. *L. variegatus* (Müller), the well-known Eurasian species is the more abundant and widely distributed form, and *L. inconstans* (Smith), was found associated with it in two localities.

Lumbriculus Grube.

Prostomium rounded, without proboscis-like elongation. Setae paired and cleft. Spermiducal pores one or two, exceptionally three; paired or asymmetrically placed on one or two somites, more commonly on 8[2] or 10. Oviducal pores usually paired in one or two somites next following those with spermiducal pores, sometimes otherwise arranged. Spermathecal pores laterad of ventral setae; usually in three to five pairs, frequently fewer or more numerous, often asymmetrically arranged; commonly posterior to spermiducal pores. Dorsal and ventral vessels connected in posterior part of each of nearly all somites by a pair of transverse vessels; dorsal vessel in anterior part of each somite, except a few anterior ones, with one pair of contractile caecal transverse appendages. Atria, one, two, or three; paired, or asymmetrically arranged in one or two

[1]Contributions from the Zoological Laboratory of the University of Illinois, No. 139.
[2]Arabic numerals are used to designate somites, counting from the anterior end.

somites. Ovaries and oviducts usually paired in one or two somites next posterior to one with atria, sometimes otherwise arranged. Spermathecae usually three to five pairs, number highly variable; commonly in somites posterior to those containing the atria.

Lumbriculus variegatus (O. F. Müller.)

Length, 40–80 mm. Diameter, 1–1·5 mm. Number of somites, 140–200, or more. Colour in life, reddish to dark brown, anteriorly greenish. Prostomium rounded conical, length about one and one-half times the basal width. Spermiducal pores usually on 8, less frequently on 7, rarely on 6, 9, 10, or 11. Oviducal pores, one to three pairs, often asymmetrically arranged, more commonly one pair on 9. Spermathecal pores highly variable in number and position, nearly always posterior to spermiducal pores and on three or more somites. Spermaries and spermiducal funnels variable in number and position, usually associated with the atria and more commonly a pair of spermaries and one or a pair of funnels in 8. Ovaries and oviducts variable in number and position, more commonly a pair of each in somite next posterior to atrial somite. Spermathecae highly variable in number and position, more commonly three to five pairs in 9–13.

This species is represented in collections from the following localities, mentioned in order of distribution from west to east; the accompanying data are given as supplied by the collector: Konganevik Point (Camden bay), Alaska, June 25–26, 1914, in mud at margin of lake. Collinson point (in Camden bay), Alaska, June 13, 1914, in mud in tundra pond (margin). Herschel island, Yukon Territory, July 30–31, 1916, pond in tundra swamp at east end. Cape Bathurst, Northwest Territories, July 26, 1916, waterhole in brook, swamp (tundra). Bernard harbour, Northwest Territories, June 28, 1915, in mud at margin of tundra pond; July 13, 1915, from green algae in streaming water (tundra); September 30, 1915, in bottom mud of big lake, one fathom water; June 6, 1916, in mud of tundra pond (shallow).

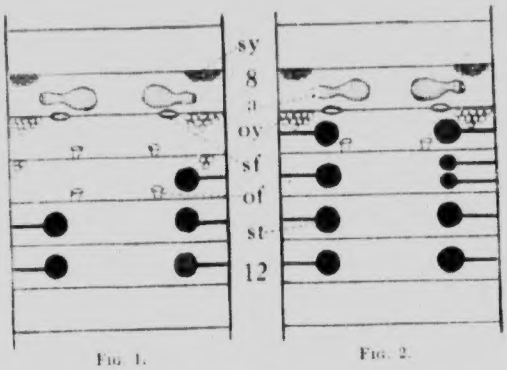

Fig. 1. Fig. 2.

Diagrams showing distribution of reproductive organs in two specimens of *Lumbriculus variegatus*. Numerals designate the somites; a, atrium; of, oviducal funnel; oy, ovary; sf, spermiducal funnel; st, spermatheca; sy, spermary.

Seven specimens of *L. variegatus*, among a total of about twenty, have at least traces of atria, and in each case they are paired in 8 and spermaries are paired in the same somite. Spermiducal funnels are found in but four of these and are also paired in somite 8. In each of the seven specimens having atria, paired ovaries and oviducts are contained in 9; an additional pair of well-

developed ovaries and of oviducts is present in 10 in one specimen; two have small ovaries and either a pair of oviducts or a single one in 10; one has small ovaries and no oviducts in 10; and three specimens have neither ovaries nor oviducts in that somite. But two specimens are in the proper stage of sex organ development to show spermathecae, and in one of them these organs are paired in 11 and 12 and there is a single one in the right hand side of 10 (fig. 1). In the other specimen spermathecae are paired in 9, 11, and 12, there is one on the left side of 10 and two on the right side of that somite (fig. 2). As will appear in the general discussion of this species, the collections contain an unusually large percentage of specimens with partially or well developed sex organs. Such individuals are ordinarily very rare. The diameters of these specimens are 1·1–1·4 mm.

Lumbriculus inconstans (F. Smith.)

Length, 30–60 mm. Diameter, 0·6–0·8 mm. Number of somites, 150–200, or more. Colour in life, reddish, anteriorly greenish. Prostomium rounded, length one and one-half times the basal width. Spermiducal pores usually on 10, occasionally on 9 or 11. Oviducal pores usually two pairs in two somites next following the one with spermiducal pores, occasionally but one pair. Spermathecal pores paired or asymmetrically distributed on four or five somites posterior to the atrial somite. Spermaries and spermiducal funnels one to three pairs, commonly two pairs in 9 and 10. Ovaries and oviducal funnels one or two pairs, commonly two pairs in 11 and 12. Spermathecae paired or asymmetrically distributed in four or five of somites 11–16.

A few specimens of this species were found associated with *L. variegatus* in the collections from the following localities: Collinson point, Alaska, June 13, 1914, in mud in tundra pond (margin). Herschel island, Yukon Territory, July 30–31, 1916, pond in tundra swamp at east end.

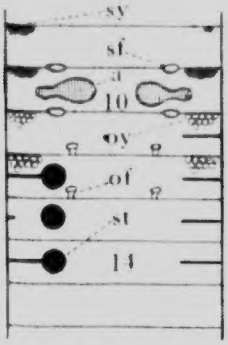

FIG. 3

Diagram showing distribution of reproductive organs in a specimen of *Lumbriculus inconstans*. Numerals and letters as in figs. 1 and 2.

But two of the specimens of *L. inconstans* have atria. One of them has paired atria in 10, but no traces of spermathecae. It has also paired spermaries and spermiducal funnels in 9 and 10, paired ovaries and oviducts in 11, one well developed ovary and one minute one in 12, but no oviducts are recognizable in that somite. Small cell aggregates that are apparently similar to rudimentary ovaries are present on one side of 13–17. Similar bodies were found by Mrázek (1907:429) in *L. variegatus*. Another specimen that is more nearly mature has also paired atria in 10 (fig. 3) and paired spermaries and spermiducal funnels

in 9 and 10. Ovaries and oviducts are paired in 11 and 12; spermathecae are present on one side of 12–14, and on the other side there are vestiges of spermathecal ducts in 11–14. The diameter of these specimens is but 0·5 – 0·55 mm. which is but half of that of the mature individuals of *L. variegatus* in the same collections.

Distribution and Systematic Relationships.

Distribution.—*L. variegatus* has long been known from various parts of Europe. Eisen (1879:11) reported specimens from several localities in western arctic Siberia as doubtfully belonging to this species. His figures and description of certain "glands" in 9–12 make it probable that he was really dealing with the spermathecae in *L. variegatus*. In an earlier paper Eisen (1872:122) also records the species in Greenland, but this is regarded by some subsequent writers as doubtful. It is now shown to have an extensive distribution in the northern fringe of the continental areas of Eurasia and North America and probably the area occupied by it is fairly continuous.

L. inconstans has previously been known only from the North Central and Great Lakes regions of the United States, and the new records greatly extend its range.

Systematic.—*L. variegatus* has had an especially prominent place in the oligochaetological literature of Europe, and is well known, not only to the systematists, but also to students of regeneration phenomena and the related morphological problems. Although it was known to Bonnet in 1745 and was formally described and named by O. F. Müller in 1774, yet it was not until 1907 that an adequate treatment of the reproductive organs appeared, when Mrázek published his paper giving the results of an examination of something over 200 sexually mature specimens. Such individuals are extremely rare and the reproductive system is extraordinarily variable, and, in consequence, earlier writers with not more than one to three specimens each had published more or less discordant accounts. These discrepancies are easily explained in the light of Mrázek's results.

The atria are found in one or more of somites 6–11. There is sometimes a single atrium, sometimes a pair, and sometimes either two or three atria asymmetrically disposed. In the latter case the atrial somites are sometimes not consecutive. The paired relation is the most common, and 8 is most frequently the atrial somite. Aside from 8, somite 7 is the one more commonly involved. The number of spermiducal funnels varies from a single one to three pairs, with the presence of a single one or a single pair in 8 occurring most frequently. Asymmetry in the arrangement of the spermiducal funnels is of frequent occurrence. Similar irregularities in the number and arrangement of spermaries, ovaries, and oviducts are found; the most common condition is one pair of spermaries in 8 and one pair each of ovaries and of oviducts in 9. An additional pair of ovaries and of oviducts in 10 is also of frequent occurrence. There is most surprising variability in the number and arrangement of the spermathecae. There were none of somites 7–17 that did not contain spermathecae in some one or more of Mrázek's series of worms. It is very common to have two or even three spermathecae on one side of a single somite with the result that as many as five and even six spermathecae in a single somite have been found. The total number of these organs in one individual has been found varying from three in one specimen to twenty-seven in another, and the number of somites containing spermathecae has varied from two to nine. In nearly all specimens, 10, 11, and 12 are found to contain spermathecae, and also in quite a large number, 9 or 13 or both have these organs, while they are found in any of the other somites far less frequently.

L. inconstans, like its congener, is very rarely found sexually mature and the few specimens thus far obtained in that condition indicate that in this species also, there is much variability in the number and arrangement of the various reproductive organs. The most characteristic difference between the two species is in the general location of these organs and in the number of spermaries and spermiducal funnels. Paired atria, spermaries, and spermiducal funnels in 10, with an additional pair of spermaries and spermiducal funnels in 9, is the usual condition in *L. inconstans*, while a single pair of atria and of spermaries in 8, and a single spermiducal funnel or a pair in that somite is the usual condition in *L. variegatus*. The spermathecae of *L. inconstans* are normally about two somites farther posterior than are those of the other species. Size is not ordinarily very significant as a distinguishing character, but no specimen of *L. inconstans* has been found with a diameter much more than half of that of ordinary mature specimens of *L. variegatus*, and now a similar difference is apparent between mature specimens of the two species when found in the same situation. This is true in each of the two collections of the expedition in which *L. inconstans* is contained.

Unfortunately there has been no series of sexually mature specimens of *L. inconstans* at all comparable in numbers with that of the European species obtained by Mrázek. Including the single specimen to which reference was made by Moore (1906 : 169), we know the position of the atria in but eleven, and of the spermathecae in but five specimens of *L. inconstans* from the Great Lakes region of North America. The atria are paired in 9 in two specimens; paired in 10 in eight specimens; and paired in 11 in one. In each of the two with atria paired in 9 there are spermaries and spermiducal funnels in 9; ovaries and oviducts in 10 and 11; one has spermathecae in 11–15, in part asymmetrical, and in the other they are undeveloped. In the specimen with the atria paired in 11, there are paired spermaries and spermiducal funnels in 9, 10, and 11; a pair of ovaries and oviducts in 12; and spermathecae in 12–16, in part asymmetrical. In two earlier papers (1895 and 1905) I have referred to this specimen with atria in 11, and included it with others in a statement that spermaries are present in 9 and 10 and ovaries in 11 and 12. A re-examination of this specimen, with greater experience in interpreting vestigial structures in these worms, has convinced me that in this particular individual, the gonads and ducts of 11 are in reality spermaries and spermiducal rather than ovaries and oviducal as previously announced. Vestiges of the funnels is about all that is present to represent the ducts, and their position indicates that they probably are spermiducal structures. In each of the eight specimens with paired atria in 10 there are paired gonads, presumably spermaries, in 9 and 10; and five of them have at least traces of spermiducal funnels in 9 and 10. In the others, recognizable traces of the funnels are lacking. Ovaries and oviducal funnels are present in 11 and 12 in each of five of these eight specimens; two others have gonads, presumably ovaries, in 11 and 12, but no recognizable funnels; and one has one pair of ovaries and a pair of oviducal funnels in 11, but none in 12, except a rudimentary gonad on one side. Spermathecae are recognizable in but five of the specimens and in some are somewhat asymmetrical, having in some somites a single spermatheca instead of a pair. One specimen with atria in 9 has spermathecae in 11–15; one with atria in 11 has spermathecae in 12–16; and of three specimens with atria in 10, one has spermathecae in 11–15, one has them in 12–15, and one has them in 12–16. The specimen described from arctic North America has them in 11–14. No two of the six specimens which have the organs all present have an identical arrangement of them.

In connection with the question of the possible identity of the two species of *Lumbriculus* mentioned in this paper, it is interesting to note that in all of Mrázek's series there were but three that had atria in 10, and each of these had an asymmetrical arrangement of these organs, there being in each case one or two atria in a more anterior somite. In at least one of the very small

number of specimens in his series having atria in 11, there was evidence of regeneration of anterior somites. This would be very likely to alter the number of somites and hence the numerical relations of organ positions.

Lumbriculus, sp.

The collection contains two small specimens having data as follows: 'Brackish pond at Teller (Port Clarence), Alaska. In moss-brink. August 3, 1913." They apparently are sexually immature specimens of some species of *Lumbriculus*. Sections of the most promising looking specimen revealed defective preservation, some evidence of regeneration of a few anterior somites, and a lack of reproductive organs except apparent traces of gonads. These latter are in somites 10–13 and possibly in one side of 9. Because of the change in the number of somites liable to occur in the process of regeneration, the location of the gonads has little systematic significance, and there is insufficient basis for identification.

The occurrence of representatives of Lumbriculidae in brackish water is at least unusual.

LITERATURE CITED, PART I.

Eisen, G.
1872. Om nagra arktiska Oligochæter. Öfv. Kongl. Vet. Akad. Forh. 29 : 119—124.

1879. On the Oligochæta collected during the Swedish Expeditions to the arctic regions in the years 1870, 1875 and 1876. Kongl. Sv. Vet. Akad. Handl. 15 : 1—49.

Moore, J. P.
1906. Hirudinea and Oligochæta collected in the Great Lakes Region. Bull. Bur. Fisheries 25 : 153—171.

Mrázek, Al.
1907. Die Geschlechtsverhältnisse und die Geschlechtsorgane von *Lumbriculus variegatus* Gr. Zool. Jahrb. Anat. u. Ont. 23 : 381—462.

Smith, F.
1895. Notes on Species of North American Oligochæta. Bull. Ill. State Lab. Nat. Hist. 4 : 285—297.

1905. Notes on Species of North American Oligochæta. V. The Systematic Relationships of *Lumbriculus* (*Thinodrilus*) *inconstans* (Smith). Bull. Ill. State Lab. Nat. Hist. 7 : 45—51.

II.—THE ENCHYTRAEIDAE.[1]

By Paul S. Welch.

Eight of the collections contained mature enchytraeids representing six species distributed among four genera. Immature specimens not permitting specific identification were also present. Serious difficulties encountered in connection with some of the material necessitated provisional identification of two species. These difficulties were mainly due to incomplete, original descriptions of arctic Eurasian species made many years ago when the Enchytraeidae were little known and before the taxonomic importance of several anatomical features was recognized. Since the original Eurasian specimens are not available, the descriptions and accompanying illustrations are the sole dependence, thus preventing positive identifications, at least in some cases. For this reason, brief anatomical descriptions of the representatives of each species treated in this report have been included and it will be understood that they are based exclusively upon the characters of the Canadian specimens. Characteristics of immature specimens are listed only in case it is unlikely that they are juvenile individuals of a species already discussed.

Henlea nasuta (Eisen.)

A collection of enchytraeids made July 7, 1915, from wet moss roots on a tundra, Bernard harbour, Northwest Territories, contained two specimens, both mature, and the posterior portion of another which exhibit the characters of *Henlea nasuta* (Eisen.)

Characteristics.—Length, 19.3 mm. Diameter, about 1.0 mm. Somites, about 58. Colour of alcoholic specimens light brown. Prostomium small; short; pointed. Setae 4–6 per bundle in ventral rows; 3–5 per bundle in lateral rows; straight; inner ones of bundle slightly smaller. Clitellum well developed; on 12–$\frac{3}{4}$13; continuous around body. Lymphocytes scanty; ovoid to circular. Peptonephridia present; one dorsal and one ventral strand; both arising from digestive tract in 5; both in close contact with wall of latter; branches projecting into coelom in 6; ventral strand longer than dorsal, extending to 8. Oesophagus expanding abruptly into intestine in 8. Two conspicuous intestinal diverticula in 8, each opening independently by single opening into latero-ventral part of the digestive tract; bag-shaped; reflected cephalad; slightly flattened laterally; large central cavity with many deep folds of lining. Dorsal blood-vessel arising in 8. Nephridia with small anteseptal and large postseptal part; efferent duct arising from anterior ventral surface of latter. Spermiducal funnel about $1\frac{1}{2}$ times longer than wide. Sperm duct confined to 12. Penial bulb of simple lumbricillid type; body of bulb composed of but one set of cells. Spermathecae with no definite demarcation between duct and ampulla; few, small, unicellular glands at ectal opening; duct about one-half as long as ampulla; body of ampulla ovoid, decreasing entad into very fine tube above digestive tract and uniting with similar tube from corresponding spermatheca on opposite side of body to form common duct; apparently uniting with alimentary canal in posterior part of 5.

Distribution.—*Henlea nasuta* was originally described by Eisen (1879 : 20–21) from specimens collected all along the Yenisei river, northern Siberia, at localities varying from 60° 50′ to 72° 40′ n. lat. According to the synonymy

[1]Contribution from the Entomological Laboratory, Kansas State Agricultural College, No. 34.

given by Michaelsen (1900 : 69), it was later reported under other names from Solowetski island in the White sea, Denmark, Germany, Bohemia, France, and Italy.

Henlea tenella (Eisen.)

Two mature enchytraeids belonging to the genus *Henlea* were collected under old driftwood logs on the tundra at Collinson point, Alaska, September 27, 1913. These specimens agree in so many particulars with the description of *Henlea* (*Archienchytraeus*) *tenella* (Eisen) that they are placed provisionally under that name. Unfortunately, the description of this species, like many of the older ones, is very brief, indefinite with respect to some features, and entirely lacking in information concerning certain important anatomical characters. In order to facilitate future revision, the principal characters of the specimens studied are given below.

Characteristics.—Length, 10·8–12 mm. Diameter, in region of clitellum, about 0·42 mm. Somites, 52–53. Colour of alcoholic specimens uniformly dark brown. Prostomium short; very blunt; rounded; smooth. Setae almost straight; inner ones of bundle slightly smaller than outer; 2–5 per bundle in lateral rows, usually 3–5; 2–6 per bundle in ventral rows, usually 4–6; number per bundle decreasing at posterior end of body. Clitellum only slightly developed; inconspicuous; on 12–13; diameter of body slightly or not at all greater at clitellum than at adjacent somites; continuous around body. Lymphocytes scanty; elliptical; variable in size. Brain 0·19 mm. long, 0·12 mm. wide; depressed; lateral margins slightly divergent caudad; posterior margin deeply emarginate; anterior margin slightly concave; one pair supporting strands from apices of posterior lobes, another pair from latero-posterior margins, both pairs extending caudo-laterad to body-wall. One pair of diminutive peptonephridia in 5 on ventral side of digestive tract; slightly branching. Chloragog cells in dense layer about digestive tract for its whole length. Oesophagus expanding abruptly into intestine in 8. Intestinal diverticulum in 8; entirely surrounding digestive tract; conspicuous in transverse section; tubular in structure, tubules uniting with intestine in posterior part of 8. Origin of dorsal blood-vessel in posterior part of 8 or beginning of 9. Nephridia with small, anteseptal part; postseptal part large, compressed; efferent duct as long as postseptal part, arising from ventral surface of latter near septum. Spermiducal funnel small; somewhat cylindrical; expanded near middle; length about twice maximum diameter. Sperm duct much contorted; confined to 12. Penial bulb small; of lumbricillid type; body of organ with but one set of cells. Spermathecae very small and simple; wall thinned to form ampulla without increasing diameter externally; no diverticula; inconspicuous glands at ectal opening of duct; spermathecae uniting dorsad of digestive tract to form small, common tube; latter connecting with lumen of digestive tract; ental portions of spermathecae very slender.

Discussion and Description.

When compared with the original description of *Henlea tenella* (Eisen, 1879 : 17), differences appear in the number of setae per bundle, the length and breadth of the brain, and the shape of the spermiducal funnel, but these disagreements are minor and cannot be regarded as having any particular importance. It is not known whether the original material from which *Henlea tenella* was described had an intestinal diverticulum, penial bulbs, and dorsal blood-vessel of the kinds herein described for the Collinson point specimens or not and an element of uncertainty thus exists in the identification. For the purpose of this report none of the anatomical features demand special mention except the intestinal diverticulum, the penial bulb, and the spermathecea.

Intestinal Diverticulum.—Structurally, the intestinal diverticulum in these Collinson point specimens resembles very closely those in *Henlea moderata* Welch and *Henlea tubulifera* Welch. The writer pointed out in an earlier paper (Welch, 1914 : 160) that a similar type of structure is reported for the intestinal diverticulum in the genus *Hepatogaster* Čejka. In fact, Čejka (1910) uses this type of structure as one of the distinguishing characters of *Hepatogaster*. However, since the Collinson point material lacks the canals in the intestinal epithelium and since the peptonephridia and spermathecae differ from those described for that genus, this species is herein recorded as belonging to *Henlea*.

This organ arises from the posterior end of the oesophagus in 8 and is reflected cephalad, closely investing the latter for almost the entire length of the somite. It occupies approximately one-half of the body-cavity in 8. A deep, narrow, longitudinal depression on the mid-dorsal side partly encloses the dorsal blood-vessel. A smaller, longitudinal depression on the mid-ventral surface partly encloses the ventral blood-vessel. The organ is largely composed of a series of branching, longitudinal, thick-walled tubules closely crowded together, which unite near the caudal end of the diverticulum and open into the lumen of the digestive tract through a few larger tubes.

It might be mentioned that Friend (1914 : 151–153) lists *Henlea tenella* under a heading "œsophageal glands absent," but, since the English record is uncertain, this statement is disregarded.

Penial Bulb.—The penial bulbs are small, being but little thicker, in transverse section of the body of the worm, than the adjacent muscle-layer of the body-wall. They are simple in structure, conforming to the lumbricillid type. Each is composed of but one set of gland cells and is covered by a well-developed muscle-layer. The sperm duct extends well into the bulb to unite with a distinctly differentiated penial lumen. In the description of the species given by Michaelsen (1900 : 70), the statement is made that the penis is much smaller than the sperm funnel but it is uncertain what part or how much of the penial bulb apparatus is referred to. If this statement applies to the whole penial bulb, it is not true for the American specimens since the penial bulb is as large as the sperm funnel although but little larger.

Spermathecae.—The original description by Eisen (1879 : 17) contains no mention of any connection of the spermathecae with the digestive tract, and his accompanying figures (Pl. III, 5g; Pl. IV, 5m) seem to indicate that they end blindly, being very much narrowed at the ental end. Since the ental extremities of the spermathecae in the Collinson point specimens are very much reduced in diameter, the writer is inclined to suspect that Eisen overlooked the very inconspicuous alimentary connection, or else examined immature specimens, since there is evidence that the connection with the digestive tract is one of the last features to be completed in the development of the spermatheca. Eisen also states that "A form with the receptacle bent at the top and somewhat longer could perhaps be separated as a variety: elongatus (Pl. IV, fig. 5m). This variety was found in Norway near Tromsö, together with *Neoenchytraeus Ratzelii*, and may be considered as a local variety or a beginning species." This "variety" was also probably described from immature specimens or else the alimentary connection was overlooked. Judging from the above description and an examination of the original figures, there seems to be no grounds for establishing such a variety.

Distribution.—The specimens studied by Eisen and classified as *Henlea tenella* were collected on Solowetski island in the White sea (65° n. lat.), at Tromsö, Norway (about 69° n. lat.) and at "Sapotschnaja Korga, Jenissej," Siberia (71° 41′ n. lat.). Aside from an uncertain record by Friend (1912 : 585–6) of its occurrence in England, no other records appear in the literature, and it thus appears that the species, as known at present, is Arctic in its distribution. Although widely removed geographically from the known Old World localities, this species apparently exists under similar conditions in arctic America.

Henlea ochracea (Eisen.)

A collection made July 26, 1916, at cape Bathurst, Northwest Territories, from a "water-hole in brook swamp (tundra)" contained two mature enchytraeids which exhibit characters very similar to those described by Eisen (1879 : 20) for *Henlea ochracea*. Eisen's description is so meager that other workers have had difficulty in using it. The writer, in a careful examination of the original description and its accompanying figures, has found so close an agreement with the Canadian specimens that they are listed here as *Henlea ochracea*, at least provisionally.

Characteristics.—Length, 12 mm. Maximum diameter, 0·7-1 mm. Somites, 47. Colour of alcoholic specimens dark brown. Prostomium prominent; smooth; rounded at tip; extending well beyond mouth. Setae straight; inner ones of bundle slightly smaller than outer; 3 5 per bundle, fewer at extremities. Clitellum on 12 13; well developed; continuous around body. Lymphocytes sparse; ovoid to circular. Brain almost as long as wide; anterior margin slightly concave; posterior margin emarginate; lateral margins divergent caudad; almost circular in transverse section. Two sets of peptonephridia arising from digestive tract in 5; dorsal pair arising as large, tubular, glandular organs, extending caudad for short distance between epithelium and muscle-layer of alimentary canal, ending in a few long branches into coelom in 6; ventral pair arising as two tubular strands, more massive than dorsal peptonephridia, also few branches into coelom in 6. Oesophagus expanding abruptly into intestine in 8. Intestinal diverticulum in 8; completely surrounding digestive tract as single organ; with numerous internal tubules. Origin of dorsal blood-vessel in 9; vessel exceptionally enlarged above diverticulum. Nephridia with very small anteseptal and large postseptal part; efferent duct arising from posterior end of latter. Spermiducal funnel about twice as long as wide; with thin, reflected collar; sperm duct in 12 only, much coiled. Penial bulb of simple lumbricillid type; but one set of cells in body of bulb. Spermathecae spindle-shaped; without distinct separation between ampulla and duct; no diverticula; two groups of glands at ectal opening; extending caudo-dorsad to union with corresponding part of opposite spermatheca; common duct leading to lumen of alimentary canal; diameter of ampulla about twice that of duct.

Discussion.—Slight differences between the Canadian specimens and those described by Eisen from Nova Zembla exist in one or two sets of organs. The spermiducal funnel in the former is not as stout as Eisen indicates in his figure, and the ampulla of the spermatheca is less distinctly set off from the duct, but these are differences of degree and are of little significance. Eisen figures several glands at the ectal openings of the spermathecae but the Canadian specimens have only two.

Distribution.—Aside from the original discovery of a few specimens of *Henlea ochracea* in Nova Zembla, nothing has hitherto been known concerning its distribution. The discovery of enchytraeids apparently belonging to this species in arctic North America is therefore a matter of interest and indicates for this annelid a wide distribution.

Henlea arctica, n. sp.

A collection made July 2, 1915, from the mud at the margin of a tundra pond, Bernard harbour, Northwest Territories, contained six enchytraeids, two of which were mature. These annelids show a combination of characters which does not seem to agree with descriptions of species already known. In some respects, they appeared to resemble certain poorly described species and incomplete descriptions have made the determination very puzzling, but the lack of complete agreement has led to the final conclusion that these worms must be regarded as representing a new species.

DEFINITION.—Length, 6·3–13 mm. Diameter, about 0·45 mm. Somites, 40–51. Colour of alcoholic specimens light brown. Prostomium blunt; round; smooth. Setae 3–5 per bundle in both lateral and ventral rows, fewer at extremities; all in bundle about same size; distinctly sigmoid, distal points recurved. Clitellum slightly developed; on 12 13. Lymphocytes scanty; ovoid. Brain about one and one-half times longer than wide; anterior and posterior margins slightly concave; lateral margins divergent caudad; two pairs of supporting strands from posterior part. Peptonephridia present; one dorsal and one ventral strand; dorsal strand arising from digestive tract in 5 and extending caudad, thickened at origin, in contact with wall of digestive tract to posterior part of 7 and extending under intestinal diverticulum, giving off branches into coelom in 6; ventral strand also in contact with walls of digestive tract in 3, 4, and 5, tubular, rather thick walled, apparently no branching but merely irregular folding. Oesophagus enlarging abruptly into intestine in anterior part of 8. Intestinal diverticulum of peculiar structure; completely surrounding digestive tract in 7; thin walled; large internal cavity; very few folds of lining; no evidence of internal tubules; longitudinal, mid-dorsal partition separating internal space into right and left parts; connection with digestive tract very obscure and not definitely determined. Dorsal blood-vessel arising in 8. Nephridia with anteseptal part as mere nephrostome; postseptal part large; efferent duct arising from ventral surface of latter near septum. Spermiducal funnel but little longer than wide; with thin, reflected collar; attached end merging gradually into sperm duct for some distance. Sperm duct in 12 only; much coiled. Penial bulb of simple lumbricillid type; small, maximum diameter only about one and one-half times greater than that of ventral nerve cord in same transverse section; cells of one kind only in bulb. Spermathecae with one group of very small glands at ectal opening; duct expanding gradually into globular ampulla; ental end of ampulla joining corresponding part of opposite spermatheca, dorsad of digestive tract, to form a common duct leading into digestive tract in posterior part of 5; diverticula lacking.

Henlea, sp. (a).

Among the specimens collected at Pihumalerksiak island (Cockburn point), Northwest Territories, July 15, 1916, from between moss roots, one specimen was found which, though too immature to identify to species, showed clearly the characters of the genus *Henlea*. There are some indications that this specimen may be an immature *Henlea nasuta* (Eisen).

Henlea, sp. (b).

The collections from Bernard harbour included one bottle containing four specimens from the mud of a shallow tundra pond, May 31, 1916. Two of the specimens were hopelessly deteriorated while the other two were immature, thus making specific identification impossible. The two best preserved specimens were sufficiently developed to make it certain that they belong to the genus *Henlea*. There is some evidence that these specimens are immature examples of the same form listed provisionally on a preceding page as *Henlea tenella* (Eisen).

Enchytraeus hyalinus, var.

A collection from Pihumalerksiak island (Cockburn point), Northwest Territories, July 15, 1916, contained eighty-seven specimens, of which about one-fifth were mature. These enchytraeids were collected among moss roots, and described in the field notes as "white worms," referring, no doubt, to the

colour of the living specimens. An inspection of this collection indicated that more than one species was represented, and this was confirmed by subsequent examination of cleared specimens and serial sections of selected individuals. Not all of the material was sectioned and, since specific identification depends upon such procedure, the identity of many of the worms was judged from the external examination of cleared specimens and a comparison of the results with those obtained by a study of the sectioned specimens. Most of this collection belongs to a variety of *Enchytraeus hyalinus* (Eisen). The other species represented (*Henlea* sp. (a) and *Mesenchytraeus johansseni* n. sp.) are referred to elsewhere. Unfortunately, the original description of *hyalinus* is meagre, certain important structural features being unmentioned.

CHARACTERISTICS.—Length, about 11 mm. Maximum diameter, about 0·5 mm. Somites, about 50. Colour "white" according to collection record; alcoholic specimens yellowish brown. Setae straight; those of a bundle equal in size; 2–3 in lateral bundles, mostly 3; almost invariably 3 in ventral bundles, except in immediate vicinity of extremities. Clitellum on 12–13; moderate in size; incomplete on mid-ventral surface. Prostomium blunt; rounded; smooth. Lymphocytes sparse; small; ovoid to circular. Brain about 1·8 times longer than wide; lateral margins divergent caudad; anterior margin very slightly concave; posterior margin straight or very shallowly concave; nearly circular in transverse section through middle. One pair peptonephridia arising from mid-dorsal part of oesophagus in 4; strands arising independently but almost in contact; unbranched; thick-walled; somewhat contorted; each strand extending ventro-laterad from point of origin; thin-walled, somewhat spherical expansion in middle of length of each organ, walls differing in structure from adjacent ones; both organs confined to 4. Dorsal blood-vessel arising in 14. Anteseptal part of nephridia small, comprising little more than mere nephrostome; postseptal part large, efferent duct arising from posterior end of postseptal part. Spermiducal funnel about three times longer than wide; sperm duct short, confined to 12. Penial bulb of the typical enchytraeid type as defined by Eisen (1905 : 7–8); consisting of separate and distinct sets of glands, each opening independently on surface of body; mainly composed of two well-developed, multi-cellular, spherical glands or "cushions" on each side of body, arranged in longitudinal sequence and close together but not in contact; sperm duct opening to exterior independently of anterior gland on its ectal side; cells in glands apparently all of same kind.

DISCUSSION AND DESCRIPTION.

When compared in detail with the original description of *Enchytraeus hyalinus* (Eisen) (1879 : 26–27), it is noted that the correspondence is very close for all of those features mentioned, with the exception of the form of the spermathecae. It appears that the specimens from Nova Zembla on which the original description was based had spermathecae which showed an atrium-like enlargement of the duct. No such enlargement appears in the spermathecae of the Canadian specimens. There is some resemblance to the spermathecae in *Enchytraeus marinus* as described by Moore (1902 : 80–82).

LYMPHOCYTES.—The original description also states that no "perigastric cells" (lymphocytes) are present in the Nova Zembla material. If such observation was correct, another difference appears since lymphocytes do occur in the specimens from northern Canada.

DEVELOPING OVA.—Masses of developing ova occurred in the usual position in 12. In addition, ova were observed in the body-cavity scattered at intervals from 29 to 42 inclusive. The remoteness from the oviducal pores makes it doubtful if such ova ever pass to the exterior.

DISTRIBUTION. - Thus far *Enchytraeus hyalinus* has been definitely known only from Nova Zembla. The habitat of the original specimens is not given. Friend (1912 : 222 223) has described, apparently with some hesitation, a variety of *hyalinus* under the name *densus* from specimens existing under inland conditions in England. The brief description of this variety corresponds closely with that given above for the North American forms, with the exception of the spermathecae. The structure of the penial bulb is not described and no comparison is possible. Until this variety *densus* is more certainly and more completely described, the writer prefers to leave this arctic American variety without a name.

Mesenchytraeus johanseni, n. sp.

As mentioned before, the collection made July 15, 1916, from moss roots on Pihumalerksiak island (Cockburn point), Northwest Territories, contained enchytraeids other than *Henlea* sp. and *Enchytraeus hyalinus* var. About ten of the specimens show characters of the genus *Mesenchytraeus*. All of these specimens which were sectioned proved to be representatives of a new species of *Mesenchytraeus*, which is named in honour of the collector.

DEFINITION.- Length, 12 14 mm. Diameter, about 0·7 mm. Somites, 55 57. Colour "white" according to field notes accompanying specimens; light yellowish in alcohol. Prostomium blunt; smooth; rounded. Head pore near tip of prostomium. Setae sigmoid; similar in size; 3 5 in ventral rows, 2 4 in lateral rows, fewer at extremities. Clitellum well developed; on ½11-13 Lymphocytes scanty; ovoid. Dorsal blood-vessel arising in 22 23; cardiac body present. Chloragog cells with heavy load of brownish-black pigment. Nephridia with typical mesenchytraeid structure; anteseptal part small; postseptal region large; efferent duct arising from ventral part of latter near septum. Spermiducal funnel about one and one-half times longer than wide. Sperm ducts elongate, extending caudad to 16 within ovisac; much contorted. Testes massive; undivided. Sperm sac present; single; extending caudad to 16; within ovisac; bifurcating at posterior end. Ovisac present; extending caudad to 16; bifurcating at posterior end. Penial bulb of mesenchytraeid type; small; atrium present, largely within body of bulb, about five irregular atrial glands extending into coelom; no accessory glands observed. One pair spermathecae; few unicellular glands at ectal opening; no distinctly differentiated ampulla, body of organ and duct of about same diameter; each spermatheca joining digestive tract very near mid-ventral line in posterior part of 5; each with two long, slender diverticula extending dorsad over alimentary canal.

The above description is based upon a careful study of three mature specimens. This species exhibits some resemblances to *Mesenchytraeus solifugus* (Emery), but lack of agreement appears in such features as the amount of pigmentation, place of origin of the dorsal blood-vessel, number of atrial glands, and presence or absence of accessory glands.

Lumbricillus lineatus (Müll.

One specimen belonging to the genus *Lumbricillus* was collected under sea-weed on the beach at Bernard harbour, Northwest Territories, June 12, 1916. The posterior part of the body of the worm was badly deteriorated but fortunately the anterior 19 20 somites were in a fair state of preservation and thus specific identification was possible. The specimen lacked a little of being completely sexually mature but the development of the various organs was sufficiently completed to make it evident that the worm is *Lumbricillus lineatus* (Müll.).

Another collection made on July 19, 1915, from green algae in a creek outlet, Barnard harbour, Northwest Territories, contained twenty-five specimens, of which fourteen were mature. All the specimens of this collection which were sectioned also proved to be *Lumbricillus lineatus* (Müll.).

CHARACTERISTICS.—Length, about 10–12 mm. Somites, about 50. Diameter, in region of clitellum approximately 1 mm. Colour "yellow brown" according to data accompanying the June 12th collection; dark brown in alcohol. Setae sigmoid; approximately uniform in size; 4–6 in ventral bundles; 3–4 in lateral bundles. Clitellum slightly developed; on 12–13; incomplete on ventral surface of body. Anterior and posterior margins of brain slightly concave; lateral margins divergent caudad; length apparently about equal to maximum width. Peptonephridia lacking. Dorsal blood-vessel arising in 14. Nephridia with very small anteseptal part and large postseptal part; efferent duct arising from ventral surface of posterior part of latter. Testes multilobed. Spermiducal funnel cylindrical; about three times longer than diameter. Sperm duct confined to 12. Penial bulb of typical lumbricillid form; cells of one kind only in interior. One pair spermathecae in 5; thick-walled; no diverticula; duct and ampulla large, without sharply defined line of division; ental region much narrowed and reflected cephalad before reaching digestive tract; duct shorter than ampulla, surrounded full length by conspicuous glands; ental portion of each spermatheca uniting independently with dorso-lateral surface of digestive tract; lumen of spermatheca uniting with lumen of latter. Ventral glands in 13 and 14; anterior larger than posterior; similar in shape; surrounding ventral nerve cord closely on ventral and lateral surfaces only.

DISCUSSION AND DESCRIPTION.

COLOUR.—The data accompanying the June 12, 1916, specimen contained the statement "yellow brown worm," which the writer interprets as referring to the colour of the living animal. Since *Lumbricillus lineatus* has been described from other regions as being brownish red, or red tinged with yellow, it would appear that the Bernard harbour form is typical so far as colour is concerned. No data are available on the colour of the living worms in the collection of July 19, 1915.

SPERMATHECAE.—In the specimens collected July 19, 1915, the spermathecae were as described above, but in one specimen collected June 12, 1916, they lack the connection of the lumen of the ampulla with that of the digestive tract. The ental portion of each spermatheca is adherent to the digestive tract but the connection has not yet been established. That this is a condition of immaturity is suggested by the fact that there is evidence that such connection is the last of the parts of the spermatheca to be completed. The total absence of spermatozoa in the spermathecae also indicated immaturity.

PENIAL BULB.—It is interesting to note that in the single, partially immature specimen, collected on June 12, 1916, there is a distinct difference in the development of the penial bulb on the two sides of the animal. The right penial bulb is appa[illegible]y completely developed, and all of the parts are represented in their usu[illegible]dition in the lumbricillid type. However, on the left side, the bulb is in [illegible]ery early stage of development, represented only by a small mass of deve[illegible]g tissues in the body-wall, and none of the regions of the fully-developed bulb can be distin[illegible]ied. Mature specimens in the other collection showed the penial bulbs with [illegible]structure as previously described (Welch, 1917a : 128).

DISTRIBUTION.—The writer (1917a : 123–125) has recently pointed out that the enchytraeids formerly regarded as distinct and designated under the names *litoreus*, *subterraneus*, *verrucosus*, *lineatus*, and *agilis*, are all one and the same. This synonymy must, of course, be taken into account in considering

the matter of distribution. It was also shown that *lineatus* is evidently a cosmopolitan form, having been reported from England, Ireland, Scotland, Hebrides, North Russia, Denmark, Germany, France, Bohemia, Switzerland, Terra del Fuego, and the coast of the New England States. It occurs commonly under sea-weed on the shore in various parts of the globe. It has also been found existing under fresh-water conditions.

Lumbricillus, sp. (a).

A collection from Pihumalerksiak island (Cockburn point), Northwest Territories, July 15, 1916, contained thirty-three enchytraeids, of which thirty-two were of similar size and general external appearance. These worms were taken from the mud in a "water hole." Unfortunately, none of them are mature and specific identification is impossible. However, all the specimens examined in detail show the testes composed of a number of distinct lobes—a character which has been regarded as diagnostic of the genus *Lumbricillus*. Mention should be made of the fact that these specimens, while possessing the divided testes, have straight setae—a feature which departs from the usual definition of the genus *Lumbricillus*.

Lumbricillus, sp. (b).

The above mentioned collection from Pihumalerksiak island (Cockburn point), Northwest Territories, July 15, 1916, also contained one specimen which shows distinct differences when compared with the other individuals of the same lot. The significant feature is the possession of sigmoid setae. It also exhibits the divided condition of the testes and apparently belongs to the genus *Lumbricillus*. However, the immaturity of the specimen prevents a specific identification.

General Considerations.

Pigmentation.—In an earlier paper, the writer (1916 : 120) discussed the presence of the pigmentation which occurs in all of the known glacier enchytraeids and pointed out that it does not seem possible to explain its presence on the grounds of low temperatures, since certain species in warmer latitudes show pigmentation while others in frigid conditions show no indication of it. In this connection, it is interesting to note that none of the specimens collected in arctic Canada exhibit any marked pigmentation such as occurs in the above mentioned glacier worms. The specimens of *Mesenchytraeus johanseni* n. sp. show a heavy load of brownish-black pigment granules in all the chloragog cells but none elsewhere. This is also true of the specimens of *Lumbricillus* sp. (a). No pigmentation of any sort was observed in any of the other specimens. Additional evidence is thus presented against the view that heavy pigmentation of the internal organs in enchytraeids is directly correlated with frigid habitats.

Seasonal Relations.—According to the field records of the collector, some of the enchytraeids of this collection were found alive among moss roots in dried-out stream beds in mid-summer. Possibly this is an indication of their method of surviving drouth conditions of the summer season. At least it would appear that these aquatic worms can tolerate a marked reduction of the water in the surroundings. Another noteworthy feature is the very low temperatures to which these worms are subjected during the winter months. The remarkable resistance of certain enchytraeids to frigid conditions has been discussed in other papers (Welch, 1916; 1917b) and it is evident that the worms living in arctic Canada are also successfully adjusted to long exposure at freezing temperatures.

DISTRIBUTION OF ENCHYTRAEIDAE.—The enchytraeid collections on which this report is based are of particular interest because of the fact that nothing has hitherto been known concerning this group in the region visited by the Expedition. In fact, the entire arctic portion of the North American continent is practically unknown territory with regard to this group of animals, although, as will be mentioned later, there is reason to believe that it is abundantly represented there. Eisen (1872 : 122-123) reported *Lumbricillus profugus* (Eisen), under the name *Enchytraeus pagenstecheri* Ratzel, from Godhavn, Greenland. According to Michaelsen (1900 : 82), O. Fabricius (1870) reported *Lumbricillus minutus* (Müll.), under the name *Lumbricus minutus*, from Greenland, but the exact locality was apparently not given. Ude (1896: 27) recorded the occurrence of *Enchytraeus albidus* Henle (*Enchytraeus vejdovskyi* Eisen) at Karajak, Greenland. Emery (1898), Moore (1899), and Welch (1917b) made studies on *Mesenchytraeus solifugus* (Emery) collected in Alaska on and in the general vicinity of Mount St. Elias. Eisen (1905) studied the collections of the Harriman Alaska Expedition on the west coast of Alaska, the vicinity of Port Clarence being the northern limit. No other records occur in the literature, and it thus appears that the Canadian Arctic Expedition collections present the first indications of the enchytraeid fauna existing in the vast territory between the west coast of Greenland and Bering strait.

It will be noted that the representatives of the genus *Henlea* comprise a considerable part of the collections. Ude (1901 : 19) has already pointed out that *Henlea* is especially well represented in the arctic region. The other genera appearing in the Canadian Arctic Expedition collections are also known from other parts of the far north. The common occurrence of *Mesenchytraeus* in the high latitudes has been pointed out by Ude (1901 : 23), and on the snow-fields and glaciers of high altitudes by Emery (1898), Moore (1899), and Welch (1916 : 1917b).

The arctic Canadian enchytraeid fauna, as indicated by the collections of the Canadian Arctic Expedition, shows a similarity to that of arctic Europe and Asia which is worthy of special mention. As nearly as specific identifications have been possible, all of the species represented by sexually mature material, exclusive of new forms, are known from arctic Eurasia, four having been originally described from that region. Two species (*Henlea nasuta* and *Lumbricillus lineatus*) are apparently cosmopolitan.

While the list of enchytraeids taken by this Expedition is not extensive, and while the collections were not made in an exhaustive manner, the results confirm previous conclusions concerning the geographical relations of this family, viz., that the group is preeminently northern in its distribution. Such Arctic regions as have been examined yield evidence of a rich enchytraeid fauna. The abundance of some of these worms reported by earlier collectors is an indication of their successful adjustment to the rigid conditions of the environment. There is every indication that future collections will show the Enchytraeidae to be one of the most prevalent and most widely distributed of the groups of animals occupying the north frigid zone.

LITERATURE CITED. PART II.

Cejka, B.
1910. Die Oligochaeten der Russischen in den Jahren 1900–1903 unternommenen Nordpolarexpedition. I. Ueber eine neue Gattung der Enchytraeiden (Hepatogaster). Mem. Acad. Sci. St. Petersb., (8), 29, No. 2, 1–29; 3 pl.

Eisen, G.
1872. Om nagra arktiska Oligochaeter. Öfv. Ak. Forh., 29 : 119–124.

1879. On the Oligochaeta collected during the Swedish Expeditions to the Arctic Regions in the Years 1870, 1875 and 1876.
Kong. Sv. Vet. Akad. Handl., Bandet 15, No 7, 49 pp.; 16 pl.

1905. Enchytraeidae of the West Coast of North America. Harriman Alaska Expedition, 12 : 1–126; 20 pl. New York.

Emery, C.
1898. Diagnosi di un nuovi genere e nuova specie di Ancilidi della famiglia degli Enchytraeidae.
Atti della R. Accad. dei Lincei, (5), 7 : 110–111.

Fabricius, O.
1780. Fauna Groenlandica. (Original not seen.)

Friend, H.
1912a. British Enchytraeids. IV. The Genus *Henlea*. Journ. Royal Micr. Soc., pp. 577–598.

1912b. New British Oligochaets.
The Zoologist, (4), 16 : 220–226.

1914. British Enchytraeids. VI. New Species and Revised List. Journ. Royal Micr. Soc., pp. 128–154.

Michaelsen, W.
1900. Oligochaeta. Das Tierreich, 10 Lief. XXIX + 575 pp.; 13 fig. Berlin.

Moore, J. P.
1899. A Snow-inhabiting Enchytraeid (*Mesenchytraeus solifugus* Emery) collected by Mr. Henry G. Bryant on the Malaspina Glacier, Alaska.
Proc. Acad. Nat. Sci. Phil., pp. 125–144; 1 pl.

1902. Some Bermuda Oligochaeta, with a Description of a New Species. Proc. Acad. Nat. Sci. Phil., pp. 80–84; 2 fig.

Ude, H.
1896. Enchytraeiden. Hamburger Magalh. Sammelr., 42 pp.; 1 pl.

1901. Die arktischen Enchytraeiden und Lumbriciden, sowie die geographische Verbreitung dieser Familien.
Fauna Arctica, Band II, Lief. 1, 34 pp.; 2 pl.

Welch, P. S.
1914. A new *Henlea* (Enchytraeidae) from Northern Michigan. Trans. Am. Micr. Soc., 33 : 155–164; 1 pl.

1916. Snow-field and Glacier Oligochaeta from Mt. Rainier, Washington. Trans. Am. Micr. Soc., 35 : 85–124; 4 pl.

1917a. The Enchytraeidae (Oligochaeta) of the Woods Hole Region, Mass. Trans. Am. Micr. Soc., 36 : 119–138.

1917b. Alaskan Glacier Worms (Oligochaeta). Bionomical Leaflets, McGill University, Montreal, No. 2.